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STRIDULATING ORGAN OF THE CICADA.

JOURNAL

OF THE

NEW-YORK MICROSCOPICAL SOCIETY.

VOL. XI. APRIL, 1895. No. 2.

NOTES ON THE SEVENTEEN-YEAR CICADA, CICADA SEPTENDECIM.

BY E. G. LOVE.

(*Read October 5th, 1894.*)

The year 1894 offered another opportunity for the study of those remarkable insects which, appearing once in seventeen years, make our woods resound for a brief time with their discordant din.

The peculiar life history of these insects has invested them with a special interest for many besides entomologists.

Briefly stated, this history begins when the young larvæ, just hatched, fall to the ground from the twigs in which the eggs were deposited, and burrow down until they reach the roots from which they mainly draw their subsistence during their larval period of seventeen years. At the end of this period they find their way to the surface and emerge as perfect

Explanation of Plate 49.

FIG. 1.—The seventeen-year Cicada, *Cicada septendecim*. Male. About natural size.

FIG. 2.—*Cicada pruinosa*. Male. Wings and legs removed to show the valves and the position of the drum. X 1.6.

FIG. 3.—*Cicada septendecim*. Male. Wings removed, showing drum. X 1.6.

FIG. 4.—End view of first abdominal segment of *Cicada septendecim*, showing drums, muscles, and auxiliary membranes. X 3.2.

FIG. 5.—Under side of body of *C. septendecim*. Male. Showing valves. X 1.45.

FIG. 6.—End view of first abdominal segment of *C. pruinosa*, showing muscles, auxiliary membranes, and on the left the chitinous extension covering the drum. X 2.5.

FIG. 7.—Abdomen of *C. septendecim* from above, showing drums. X 1.6.

FIG. 8.—Under side of body of *C. pruinosa*, showing valves. X 1.7.

FIG. 9.—Abdomen of *C. septendecim*. Side view, showing drum. X 1.75.

insects. After mating the males soon die, and the females begin depositing their eggs in the tender twigs of the trees about them; and the history of another generation begins.

It is not my purpose to follow this life history in detail, which is doubless more or less familiar to most persons, but to call attention to some points of especial interest in the structure and habits of these insects, based upon observations made for the most part at Baychester, N. Y., and upon the examination of specimens collected there and on Staten Island.

Happily the sins which have been laid to the charge of the seventeen-year cicada are more imaginary than real. There is in the popular mind an unfortunate confusion of this insect with the grasshopper, which is commonly called a locust, and which in many cases deserves all the hard things which have been said of him.

The impression that the seventeen-year cicada is injurious to vegetation is entirely unfounded except so far as the ovipositing of the female may in certain cases injure the young twigs of trees in which the eggs are deposited. If I may express an opinion based upon my own observation, even this injury is greatly exaggerated. Only the most tender twigs, and these only on certain trees, appear to suffer the slightest inconvenience. Twigs which had been injured from this cause were the rare exception; and this applies to a large variety of trees in which the eggs had been deposited. The tree sometimes retaliated by growing about the incisions so rapidly as to entomb, or very nearly entomb, the young cicadas. As to the destruction of vegetation by the feeding of these insects, I doubt very much whether they eat anything during their short imago period. Careful observation failed to detect any of them feeding, or to show any signs of their having done so.

The examination of a large number of males did not show in a single instance any indication that the insect had taken food. Indeed, as a rule, the abdomen of the male was entirely empty. Such was not the case with the female, however, as she had the work of ovipositing, although I think the observation in regard to their feeding applies to both sexes.

When the males and females were thrown indiscriminately into a bottle of alcohol, it was noticed that a perfect gravity separation of the sexes was effected, the females invariably sinking and the males floating.

An attempt was made to raise the young larvæ by collecting the twigs containing the eggs soon after they were deposited and placing them in a moist atmosphere to prevent the drying up of the twigs. This was only partially successful, however, comparatively few larvæ being obtained in this way. A better plan is to leave the twigs on the tree until about the time for the hatching of the eggs.

The stridulating organ of the Cicada.—One of the most interesting parts of the anatomy of the cicada is the stridulating organ, or "musical apparatus," which, as is generally known, is possessed by the male only. It consists of two so-called drums, of rather peculiar construction, and a pair of large muscles. With these must be included certain other membranous structures, which having no part in the production of the sound are important adjuncts in strengthening and modifying it. The latter membranes are often mistaken for the sound-producing organ itself.

The drums are situated in small cavities, one on either side of the first abdominal segment, and in the seventeen-year cicada are entirely exposed except for the covering afforded by the wings when the insect is in repose. The same is true of the thirteen-year cicada (*C. tredecim*), which structurally is the same species. Plate 49, fig. 1, shows the male of the seventeen-year cicada, while fig. 3 gives a side view of the same insect with wings removed, showing the position of the drum.

In other species of the cicada, the drums are also situated on the sides of the first abdominal segment, but instead of being exposed are permanently covered above and on the sides by the chitinous shell of the body, which is expanded into plates immediately over the drums, thus concealing them. This is shown in fig. 2, which is a side view of our large cicada, *C. pruinosa*, with wings and legs removed. The lower edges of these plates meet the outer edges of two abdominal valves

which extend from one-third to one-half the length of the abdomen, as shown in fig. 8. In the seventeen-year cicada these valves are very short, extending only about one-fifth the length of the abdomen, as shown in fig. 5. The function of these valves is to protect the delicate membranous structures already mentioned, and also to modify the strength of the sound produced by the drums, much after the fashion of the swell of an organ.

In appearance the drum of the seventeen-year cicada resembles one of the valves of the common round or hard-shell clam, with the convex surface turned outward; and it is so placed that what corresponds with the hinge of the shell is towards the insect's head. It consists of a rather thick membrane thrown into about a dozen folds or corrugations, which are deeper towards the sides than in the middle of the drum. The outer part of each fold is considerably thickened, which gives to the drum the appearance of strongly marked lines running from side to side, and which renders it stiff and elastic. This is shown in figs. 7 and 9, which represent different views of the drum of this species. The same is practically the appearance and structure of the drum in other species of the cicada besides *C. septendecim.*

If the abdomen is separated from the thorax a pair of large muscles will be seen in the first abdominal segment. These muscles start from the same point on the lower side of the abdomen, and extend outward in either direction towards the drums and to which they are attached, giving the appearance of the letter V. These muscles are shown in figs. 4 and 6, the former being that of the seventeen-year cicada, and the latter that of *pruinosa.* The upper ends of these muscles are shown as partly detached from the drum membrane, which is owing to the fact that the photographs were made from alcoholic specimens in which more or less contraction is always found. Fig. 6 also shows on the left-hand side the chitinous covering of the drum which has been cut away on the right-hand side.

In producing the sound the cicada contracts these muscles, thus drawing in the corrugated membranes of the drums,

which by their own elasticity return to their original position when the muscles are relaxed. By these contractions and relaxations, following each other in very rapid succession, the well-known "song" of the cicada is produced.

A homely illustration of the action of this organ in producing sound is to be found in supposing the drum to be the bottom of a tin pan which is somewhat bulged. By pressing upon the convex bottom the metal surface is forced in, producing a harsh sound, which is repeated when the pressure is removed, and the bottom assumes its original form.

In the seventeen-year cicada there are two pairs of translucent membranes connected with the stridulating organ. One pair is situated immediately under the abdominal valves and may be readily seen when the valves are raised. These membranes are irregularly elliptical in form, the larger axis being at right angles to the length of the body, and their surfaces nearly parallel with it. Their anterior edges are attached to the thorax, and their posterior edges to the abdomen, the two being separated in the middle by a little spur or projection from the thorax, while small extensions of these membranes on the sides of the body connect the thorax with the horny rings or frames holding the drums. When the thorax is separated from the abdomen these membranes are of course torn.

If the cavity under the valves is further examined a second pair of membranes will be found which are permanently fixed in the first abdominal segment, their lower edges being attached to the under side of the abdomen. In form they resemble those already mentioned, but their surfaces are nearly at right angles to the length of the body. These membranes are shown in the lower part of fig. 4.

In our common cicadas the membranes just described will be found practically the same as in the seventeen-year species. In *C. pruinosa* the cavity under the valves is much larger, however, than in the seventeen-year species, and hence the valves are much larger, as is seen in fig. 8. The posterior edge of the cavity consists of a stout horny frame somewhat resembling the letter W, with the lower parts of the letter

very much widened. The membranes connecting the thorax and abdomen are less prominent than in the seventeen-year cicada, and those fixed in the first abdominal segment are set at an angle of about 45° with the length of the body, thus bringing them more prominently into view when the valves are raised. The latter when dry become somewhat iridescent, and it is these that are sometimes erroneously referred to as the sound-producing organ.

The function of these membranes in the cicada is primarily to furnish a continuous covering for the internal organs of the body, and in the case of those joining the thorax and abdomen also to allow the free motion of these parts. The membranes fixed in the abdomen are undoubtedly intended to play the part of sounding boards, intensifying the vibrations produced by the drums; and the same may possibly be true of the other membranes mentioned, especially in the case of the seventeen-year cicada. That they are not sound-producing organs is evident from the fact that they can be punctured without interfering with the insect's stridulating power; and, moreover, there does not appear to be any means of producing their vibration independently of the drums.

The Cicada Fungus.—A number of specimens, mostly males, were found which had been attacked by the fungus, *Massospora cicadina*. This fungus was first noticed, we believe, by the late Dr. Joseph Leidy, who in 1851 found from 12 to 20 specimens of *C. septendecim* "which though living had the posterior third of the abdominal contents converted into a dry powdery, ochreous yellow, compact mass of sporuloid bodies." Dr. Leidy also described and figured the fungus itself. This fungus was also described by Prof. Peck in 1879, who gave it the name it now bears.

In the specimens which I found the entire abdominal cavity was filled with a mass of spores, and the insects were still alive and able to "sing," although they were rather inactive. I did not find any portion of the fungus itself.

Cicada Huts.—Those interested in the life history of the seventeen-year cicada are familiar with the so-called huts, chimneys, or turrets which these insects sometimes construct

on emerging from the ground. These huts have been known for a great many years, and have formed the subject for considerable speculation as to why and under what circumstances the insects build them; but no theory has as yet been generally accepted as entirely satisfactory.

If it were possible to make a careful study of these huts during successive years, we should doubtless arrive at some solution of this problem in insect architecture; but the fact that we find them in the same locality only after long recurring intervals, and then very likely under different climatic conditions, renders a satisfactory explanation difficult. It is not impossible that our ordinary cicadas, under certain conditions, construct these huts, although I have never seen any. If such was the case they would be so scattered as easily to escape notice.

The cicada huts are merely extensions of the tunnels by which the insects arrive at the surface of the ground. They are composed of earth, and in this locality are usually about an inch in diameter and from one to four inches in height. They are found both in wet and in dry places, on low and on high ground, singly and in colonies of many thousands. One hut, even in a damp soil, may be surrounded by a dozen holes from which the insects emerge without making any huts; and often where we might expect to find them they are never seen. It is this peculiarity in the location of the huts which makes it difficult to account for them. If they were found only in wet places, liable to overflow, and if every insect emerging in such a locality constructed a hut we might safely conclude that they were built for the purpose of providing a moderately dry place in which to undergo the final transformation. Unfortunately the exceptions in this case are far too numerous to prove the rule.

It has been frequently asserted that the cicada, in constructing its hut and the tunnel below it, uses a "waterproof cement," which is secreted by the insect and with which the walls of the structures are impregnated, in order to exclude moisture as much as possible. While I have not sufficient experimental data at hand to disprove this assertion, I am very

much in doubt as to its correctness. I have not been able to discover anything in these structures which even remotely answered this description, and it is evident that the compression of the earthy particles on the walls of the tunnel by the body of the insect would render such surfaces somewhat more impervious to water for a time than the surrounding soil. If the cicada is a waterproofing insect, the glands which secrete this cement have been or would be a very interesting study.

It has been stated that these huts are generally closed at the top and have an opening at the surface of the ground, and that the insect finally emerges through this opening. This statement was made by Mr. S. S. Rathvon in the *American Entomologist*, and has been frequently quoted by other writers. After an examination of many of these structures obtained in this locality, I have failed to discover any which corroborate this statement. When the hut is built it appears, in the majority of cases, to be entirely closed, and when the insect emerges it does so through an opening made in the top of the hut, and not through one at the surface of the ground. Occasionally they are found as mere extensions of the tunnel without having been closed at the top at any time; and again they are scarcely more than little mounds. It seems very probable that the length of time it is to be inhabited, and its situation in an exposed or protected place may determine somewhat the nature of the structure built.

One explanation which has been offered by Prof. Riley to account for this hut-building is that it was first effected by the cicada in low and wet ground to provide a sufficiently dry abode until the time arrived for the change to the imago; and that these cicadas having been transported to high ground the tendency to hut-building showed itself in succeeding generations; or in other words that the trait was hereditary.

Another possible explanation that has been suggested is that under the influence of *unusual heat* the larvæ come to the surface before the proper time for their final transformation, and construct these huts as a protection against too great heat and possible enemies. Mr. B. Lander, who offers this explanation, bases his conclusions upon the condition of things

which he found to exist in certain sections near Nyack, N. Y. In one locality mentioned the huts were very numerous in the shallow soil of the high ground, but "gradually disappeared as the ground dipped to a deep gully" having greater depth of soil, and from which the cicadas emerged in large numbers somewhat later, but without building any huts. Moreover, the month of April was phenomenally hot, and this unusual heat he supposes to have stirred to early activity the larvæ in the more shallow soil without affecting those lying at greater depth. While this theory may account for the condition of things found to exist in the Nyack region, it does not appear to be entirely adequate, since the huts are sometimes found in places in which the soil is of great depth, and which are not especially exposed. Such was the case at Baychester, where only a few huts were found and these in deep soil and so well protected that it was only after considerable search that they were discovered.

In the order of hemipterous insects there is no quiescent period in which the larva passes through its pupal changes, and possibly these changes in the cicada may be in progress during a portion of the time it is making its way to the surface. However this may be the insect, at the expiration of the seventeen years, is prompted by a natural instinct to seek the surface to pass the final period of its life. In this it is probably influenced to some extent by external atmospheric conditions. It is hardly possible, however, that the larva possesses any instinct enabling it to determine the distance to be traveled in its upward journey, nor the time required to accomplish this. Were such the case we probably should never see the cicada huts.

The time required for the larvæ to reach the surface would depend upon the depth from which they started, the nature of the soil to be tunneled, whether hard and compact or loose, and upon the directness of the line followed in their excavations. In any case some of the larvæ would miscalculate the time required, and reach the surface before they were prepared to assume the imago condition, and this number would be greater when the conditions united to favor a short passage.

Even in protected localities, where the soil was deep, larvæ lying nearer the surface would be more likely to emerge before their pupal changes were complete than those lying at greater depth.

Thus it is that the insects sometimes find themselves exposed to the upper air before the proper time for their final transformation, and are compelled to seek some temporary shelter. This is often found under sticks or stones which may be near, but more frequently they construct the huts as extensions of the tunnels.

AN UNDESCRIBED VASICOLA WITH AN INTERESTING HABIT.

BY DR. ALFRED C. STOKES,
Corresponding Member of the Society.

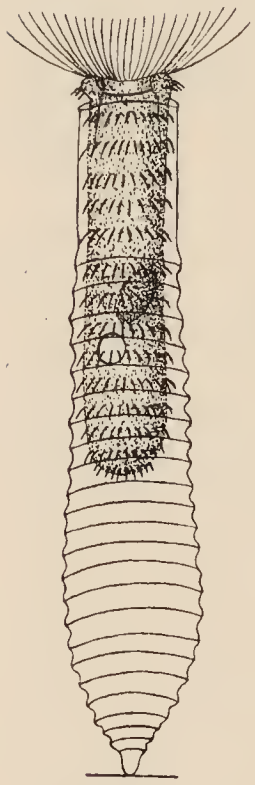
(*Read March 15th, 1895.*)

In the autumn of last year (1894), one of my correspondents sent me a gathering of filamentous Algæ, and of other microscopic objects from the brackish water of Coney Island, N. Y. This water stood on my table through the winter, being protected from evaporation, and so well protected that it was unnecessary to add any fresh water to the vessel, except the few drops needed to wash the objects from the slide back into the original receptacle. In the presence of light and warmth, and probably in the absence of those officious attentions on my part which might easily become distressing to the delicate creatures within the vessel, the gathering has thrived; generations of animals have come and gone; several forms new to science have been observed and put on record, while still others remain to be worked out and reported. It is to one of the last, an undescribed species of *Vasicola*, that I wish to devote this paper.

Up to the present time but one member of the genus has been known. This is *Vasicola ciliata*, discovered by J. G. Tatem in England, and described by him in "*The Monthly Microscopical Journal*" (I., 1869, p. 117), the type having been taken in fresh water. Our American species is therefore the only one known to have a brackish-water or a marine habitat. The following may be taken as its description:

Vasicola annulata, sp. nov.—Body of enclosed animalcule elongate-ovate or subcylindrical, less than four times as long as broad, soft, flexible, and contractile, often taking the form of that part of the lorica in which it may be; posterior extremity rounded, frequently vesicular, often somewhat inflated and changeable in shape, especially when the animalcule has left the lorica and has become free-swimming; anterior

margin truncate, slightly constricted immediately beneath the thickened peristome border; oral aperture antero-terminal, its margin ciliated; cuticular cilia fine, arranged in parallel, equatorial series, those beneath the peristome border finer and more numerous than those of the general body-surface; peristomal cilia long and fine; contractile vesicle single, in the posterior body-half, near one lateral border; nucleus spherical and subcentrally located; anal aperture antero-lateral, opening behind the peristome border. Lorica elongate-subcylindrical, usually curved, hyaline, annulate, the annulations less numerous and conspicuous, usually entirely absent, anteriorly; frontal border truncate, the margin not or but slightly everted; posterior region often somewhat inflated, tapering thence to the obtusely pointed posterior extremity, or not inflated but tapering to the truncate posterior extremity. Length of extended animalcule about 1/450 inch; height of lorica not rarely reaching 1/175 inch. Hab.— Brackish water from Coney Island, N. Y. Collected by Mr. H. C. Wells, Short Hills, N. J.



VASICOLA ANNULATA, SP. NOV. X 450.

It is especially to the Infusorian's method of engulfing its food, and to the change undergone by the endoplasm on contact with water, that I want to ask attention.

It was my learned friend, Dr. G. C. Wallich, Hon. F.R.M.S., etc., etc., of London, who first suggested that the ectosarc of the naked Rhizopoda, as well as the ectosarc of the pseudopodia belonging to the shell-bearing forms, is produced simply by a coagulation of the protoplasm of the body mass, the endoplasm of which belongs to the kind capable of undergoing this change on contact with water, as all varieties of protoplasm do not. Certain low forms of Infusoria which are scarcely distinguisbable from the naked Rhizopoda, or would not be distinguishable except for the presence of a flagellum often produced by the great elongation of a pseudopodium, possess protoplasm of the coagulable kind, so that, as with the Rhizopoda, when the pseudopodium is withdrawn, its

ectosarc disappears, having been dissolved, or made diffluent upon contact with the more fluid endosarc. The ectosarc is nowhere more than a temporary membraniform covering, produced solely by the thickening of that part of the protoplasm at the moment when the water touches it, and destined to become endoplasm again after its withdrawal into the body. The change of endoplasm into ectoplasm takes place immediately; the change of ectosarc into endosarc is usually as rapid, yet it not rarely happens that a trace of this thickened investment remains momentarily visible after the return of the pseudopodium into the body of the Rhizopod. It is not often, however, that we have the opportunity to see the production of a membraniform ectosarc in an Infusorian so high in the scale as the Heterotrichous *Vasicola*. All such formations are commonly confined to those forms not higher than the Rhizomastigidæ. Yet with the Infusorium which I have named *Vasicola annulata*, we have a brilliant example of it.

The oral aperture opens directly into the body-endoplasm without the intervention of a distinct pharyngeal passage, although the food-masses usually take a certain, invariable course in their descent, and at times a narrow tract is rather conspicuously visible leading from the oral region into the protoplasm toward the body-centre. But the oral aperture is permanently open, except perhaps during the contracted condition of the animalcule. This arrangement brings the superior surface of the body-endoplasm immediately beneath this orifice, the height of the peristome border being the distance between them. The protoplasm is therefore continuously in contact with the water, and being of the coagulable variety, the surface presents the aspect of a doubly contoured membrane. It is nothing more nor less than a layer of ectosarc, in every way comparable with the membraniform covering of an *Amœba* or of the pseudopodia of a *Difflugia*. This pseudo-membrane is always present across the front when the animcalcule is contracted, or when it is extended but not taking food.

The food particles swept into the oral aperture by the ciliary currents, are received upon the ectosarc-like partition,

and as the minute bodies accumulate, the pseudo-membrane becomes distended, and projects downward and inward more and more as it becomes pocket-like, and continues to enlarge as the food mass increases in size, until finally the burden seems to become too great for the adhesions of the sac thus formed, when the whole falls away, the endoplasm closing in front of the mass and there immediately re-forming as a membranous partition beneath the oral aperture, having given some of its substance to surround the food mass, which, entirely enclosed in a doubly contoured ectosarc sac, descends into the body. Once arrived within the endoplasm, the ectosarc-like investment may, and usually does, immediately melt away and become invisible, although this is not the invariable event. It may remain for some time, and continue visible as a doubly contoured membrane about the mass. No occurrence quite parallel to this comparative permanence of the coagulated protoplasm when within and in contact with the fluid endosarc can be mentioned.

But this is not the common event. The rule is that the ectosarc-like investment at once melts away, and the food mass becomes slowly disintegrated. The action is usually strictly analogous with the disappearance of the pseudopodial ectosarc within the endoplasm of the Rhizopod, the only apparent difference being in the rather slower action of the infusorial endosarc.

Vorticella and other Infusoria are in the habit of amalgamating the food particles into a mass, before allowing them to enter the body-substance, mingling with them a mucous secretion by which they become mutually adhesive. In the case of *Vasicola annulata*, however, the mass is surrounded by the coagulated endoplasm, a new envelope being produced for every food-mass engulfed.

The food consists of bacilli, minute vegetal spores, and of unrecognizable particles, occasionally of a diatom, which descends as a subspherical bolus along one lateral border, generally taking the same course along the side of the body opposite to that upon which the anal aperture opens.

This temporary pocket-like receptacle has the ability to

eject its contents at will, a power which it not infrequently exercises.

Tatem, in his description of *Vasicola ciliata*, remarks that reproduction by transverse fission is not rare, he having witnessed it upon several occasions. This is probably the method with *Vasicola annulata*, as two zooids are at times observable within the same lorica, one extended in the frontal region, the other completely contracted in the posterior portion. I have not seen the act of division.

Like the fresh-water species, the brackish-water form can voluntarily leave the lorica, to which it is in no way attached, and become a free-swimming organism. During this phase of its life, it is remarkably extensile, and somewhat changeable in shape, especially at the posterior extremity.

The lorica varies in length with age, often being nearly three times the length of the enclosed animalcule, varying, too, in its curvature, which is at times conspicuous, occasionally being so great that the posterior one-third becomes almost horizontal, and is then partly concealed beneath the flocculent matters to which the Infusorian prefers to attach itself.

The figure represents a form in which the lorica shows much less curvature than usual.

A NEW DIATOM FROM THE CALIFORNIA FOSSIL DEPOSITS.

BY WILLIAM A. TERRY.

(*Read April 5th, 1895.*)

Brunia Californica, sp. nov. Valve, a very large disc, belonging to Tempère's new genus, "*Brunia*," but apparently much larger than his *Brunia Japonica*, and without the strongly marked border between marginal figures and central portion. (Le Diatomiste. Pl. IV. Fig. 4.) Disc composed of two membranes; inner one finely but irregularly punctate, outer one finely striate, with radial lines, punctate. Margin with row of pseudo-nodules or depressions, from each of which extends toward central portion of disc a rapidly diminishing series of crescentic, cordate and circular markings. Varieties with marginal figures, alate, lanceolate, or cuspidate in form, rising abruptly between depressed portions of disc to form rounded elevations. Marginal figures apparently forming a third membrane, lying upon, but separate from disc membrane. Disc membrane extending downward at right angles from margin, to form the extraordinarily broad zonal band, which is very finely striate with hexagonal markings.

Habitat—Alhambra deposit, California, and Floating Fossil of 1889, Santa Monica, California.

The species has five or six well-marked varieties, but I prefer to await the result of future investigations before naming them; more especially since I have suspected that one variety, which I called *nodulosa*, may be merely the disc, after being denuded of the membrane containing the marginal figures. Findings, so far, consist of fragments only. I have been assisted in making the foregoing determination by the observations and advice of Dr. Alfred C. Stokes and Prof. C. Henry Kain, and I believe both accept my conclusions.

Even the common forms of the California deposits being mostly in fragments, it is not very likely that so large a disc

will be found entire, especially as it is so fragile. The specimen containing these fragments was collected for me at my request by Mr. Murrey Horne, of Alhambra, California. The stratum is quite thin, hard and compact, and contains the fragments abundantly; but they do not occur in other strata of the deposit, which I believe is quite extensive. The other species deposited with these fragments indicate to me that they were deposited on a littoral plain, and if the species are now living I should look for them within the laminarian zone. I think they grew in comparatively shallow water where they were protected from violent disturbances. The Floating Fossil of 1889 from Santa Monica does not contain them so abundantly, but has the same varieties, with another, in which the marginal figures are more elongated radially, and more abruptly elevated, forming a closely undulating outline when viewed horizontally. I have not found a fragment containing the entire breadth of the zonal band; but have found very broad fragments of both edges. I hope future investigations will clear up several points that are still obscure.

PROCEEDINGS.

Meeting of January 4th, 1895.

The President, Mr. Charles S. Shultz, in the chair.

Twenty-nine persons present.

Dr. John Carnrich was elected a resident member of the Society.

Messrs. Henry C. Bennett and Thos. B. Briggs were appointed by the chair tellers of the election of officers.

Mr. George William Kosmak read a paper, entitled "The Dermal Armor of the Sturgeon." This paper was illustrated by pen drawings and preparations of unusual excellence, and is published in this volume of the Journal, p. 1.

At nine o'clock P.M. the polls were declared closed, and the following persons were declared elected officers of the Society for the year 1895:

President, Edward G. Love.

Vice-President, Frank D. Skeel.
Recording Secretary, George E. Ashby.
Corresponding Secretary, J. L. Zabriskie.
Treasurer, James Walker.
Librarian, Ludwig Riederer.
Curator, George E. Ashby.
Auditors, { F. W. Devoe, F. W. Leggett, E. A. Schultze.

Annual reports were presented by the Treasurer, Curator, Librarian, Corresponding Secretary, and Committee on Publications.

On motion it was resolved that the amendments to the by-laws proposed by the committee on that matter be adopted, and that five hundred copies of the amended by-laws be printed.

Meeting of January 18th, 1895.

The President, Dr. Edward G. Love, in the chair.

Twenty-six persons present.

Dr. George W. Weld was elected a resident member of the Society.

The retiring President, Mr. Charles S. Shultz, read the Presidential Address, entitled "The Work of the New-York Microscopical Society during the past year, with personal reminiscences." The address was a resumé of the work of the Society as exemplified by its published transactions and proceedings, coupled with notices of certain valuable extemporaneous addresses which were not available for publication, and also with certain personal references to and commendations of the workers.

Objects exhibited.

1. Metallic cadmium crystallized: by Edw. G. Love.

2. Alloy of gold, silver and copper, gold 60%, silver 30%, the crystals obtained by fusion: by Edw. G. Love.

3. Transverse and longitudinal sections of bituminous coal, showing vegetable structure and infiltration of silicious matter: by Edw. G. Love.

4. Photomicrographs: Transverse section of coal; Longitudinal section of coal; Foraminifera from England; Shells of *Littorina* from Cruxhaven; Spiracles of larva of *Attacus cecropia* L.: by Edw. G. Love.

5. Red Snow, *Protococcus*, collected on Mt. Shasta in September, 1892, and prepared by Prof. Brewer of New Haven: by George Blake.

Mr. C. F. Cox referred to the communications made to the Society in 1888 by Mr. J. D. Hyatt, concerning the changes of color occurring in the cast skin of a chameleon, and spoke of observations recently made by himself upon living specimens of *Anolis principalis*, the Florida lizard, which has been for the past two or three years an article of traffic and a common pet in this city. He said it was very easy to witness the animal's changes of color under the microscope. For this purpose the lizard must be put in the dark and kept quiet for a while, during which time the stage of the microscope should be covered with cloth and prepared for the reception of the animal. If it has remained long enough undisturbed it will be found, when brought to the light, to have taken on a brilliant green color. It should be quickly placed under a low-power objective, fastened down in some gentle manner, and illuminated by means of a bull's-eye condenser. Thereupon the almost metallic green will begin to show an intermixture of red, the red will deepen and the green thin out until a bright brown has become the prevailing tint; then the red will fade from the brown and a dull earthy hue will prevail, which, under some circumstances, may pass on to a nearly colorless gray.

The idea suggested by Mr. Hyatt that the color change is effected by a raising and lowering of the epidermal scales is not confirmed by observations upon this particular lizard. During the whole process no movement whatever occurs in the scales or skin. The changes are entirely confined to the contents of the large superficial cells.* These contents consist of a sarcode-like mass of colored plastides,

* See the statement of this by Rev. Samuel Lockwood, Ph.D. This Journal, ix. 59. (Editor.)

some green and some red. During the process of color-change these pigment-bearing bodies move over and around one another, producing in the mass which they compose the peculiar kneading operation characteristic of active protoplasm. The final result is as if the plastides of one color sank to the interior of the cell while those of the other color came to the surface.

Experiments were made to test the ability or disposition of the lizard to adapt its hue to that of the object upon which it was placed, but no evidence was obtained that it possessed any such power, or that the color of the object had any influence upon the animal. The conclusion reached was that the bright green color prevailed when the animal was in a state of nervous repose, and that the change to the darker tints was induced by discomfort, or excitement,—particularly by fear.

Mr. Cox spoke of the habits of similar lizards observed by him in Southern Europe, and suggested that, in view of what he had seen, the protection which this color-change afforded the animal might be a result of the reflex nervous action which he had described,—perhaps in some such manner as the following: When the lizard is in a condition of contentment and quiet,—lying for example on or amongst congenial foliage,—it involuntarily assumes a color which happens to harmonize with that of its environment. When, however, it is alarmed by the approach of an enemy, it instinctively runs back onto the brown or reddish limb, whereupon it quite as involuntarily takes on the color of the limb. When crossing the gray earth or a bare stone wall in pursuit of its prey, being then in its most exposed position, and consequently under the greatest possible excitement, the change in its pigment cells may extend to the point of entire obliteration of color, and thus prove a benefit to it under even the most adverse of circumstances.

Dr. T. O. Summers said that in Florida it was a very common occurrence to see children strike these creatures for the purpose of making them turn brown.

Mr. C. Van Brunt related his experience with one of these animals which employed the folds of an old felt hat as a lurk-

ing place while watching for flies, and apparently making nearly successful attempts to match its color with that of the hat.

Mr. Kosmak inquired if there was any record of any experiment with these color changes after the animal had been deprived of sight, and referred to the experiments of Cunningham of Birmingham, England, who, by continuous reflection of light on the under white side of the English sole, had succeeded in causing the development of brown pigment cells on this white side of the fish.

Meeting of February 1st, 1895.

The President, Dr. Edw. G. Love, in the chair.

Twenty-two persons present.

The following persons were appointed by the chair delegates to the council of the Scientific Alliance of New-York: Charles S. Shultz, Frank D. Skeel.

The following committees were appointed by the chair:

Committee on Admissions: Thos. S. Nedham, Henry C. Bennett, Geo. H. Blake, Frederick Kato, W. J. Lloyd.

Committee on Publications: J. L. Zabriskie, Frank D. Skeel and Edw. G. Love (by election).

Mr. E. A. Schultze read a paper, entitled "Remarks on the Diatom, *Triceratium Zabriskiei* Cunningham."

OBJECTS EXHIBITED.

1. Crystallized native Copper from the Lake Superior region: by Frederick Kato.

2. Pollinia of *Asclepias:* by E. G. Love.

3. Section of leaf of *Ficus elastica* with cystoliths: by E. G. Love.

4. Section of bark of Wild Cinnamon, *Canella alba*, with crystals: by E. G. Love.

5. Photomicrographs: cystoliths of *Ficus elastica;* section of bark of *Canella;* sections of common Soap Bark; section of leaf of Wild Strawberry; pollinia of *Asclepias:* by E. G. Love.

6. Native Copper in Calcite: by Geo. E. Ashby.

7. Pyrite crystals on Calcite crystals from Kingsbridge, N. Y.: by GEO. E. ASHBY.

8. Dendrites in Semi-Opal from Cuba: by GEO. E. ASHBY.

9. Fibre Chamois, a new dress-lining: by G. W. KOSMAK.

10. Insects in Gum Copal: by F. W. LEGGETT.

Mr. Kato stated that his exhibit showed well-defined octohedral crystals of native copper, this octohedral form not being very common.

The President explained with blackboard drawings the pollinia of *Asclepias*—the aggregation of the pollen, the action of the gland in attaching itself to visiting insects, and compared this with the operations in the fertilization of certain orchids. He also stated that without the use of polarized light his photomicrographs of *Canella* bark would not have shown the presence of crystals.

Mr. Ashby said that the dendrites of his exhibit were very similiar in appearance to those of moss-agates, but were of very different material.

Mr. Kosmak said he found "Fibre Chamois" was used extensively for lining the present fashionable great sleeves and the skirts of ladies' dresses, and the prepared slide showed that the material was chiefly wood pulp, leading one to marvel at the high price charged for this material in the market.

Mr. Leggett's description of his exhibits of insects in gum copal lead to some discussion:

Mr. Ashby said that two kinds of gum copal were common in the market; the ordinary hard gum, with the "goose-flesh" surface; and an inferior smooth softer gum mixed in by the natives at the sources of production for the purpose of adulteration. The "goose-flesh" surface of copal is not due to contact with sand, but seems to be due to some oxidization, and contraction of the outer portions. A softened surface is natural to many gums, and is frequently removed by the use of alkalies.

Mr. Kato said he had a specimen of a spider in copal, the position of the creature giving evidence of a severe struggle for freedom just before death.

Mr. Ashby remarked that spiders are not common in copal, but ants and small beetles are common, and that he had a specimen of a small moth in copal, which in its struggles had left a trail of a cloud of scales; and also another specimen which appears to be a larva with a bubble in fluid contained in the body.

Mr. Walker said he formerly had a specimen of copal with a movable enclosed bubble, but in polishing it he unfortunately cut too close and ruined the cavity. And in answer to a question by Dr. Skeel as to the operation of polishing such gums, Mr. Walker advised: cut with a knife and file, smooth on Scotch stone, and polish with a mixture of Vienna lime and alcohol applied with the finger.

Dr. Love said he had occasion to examine the fibre of certain Chinese silk garments, which appeared to be coated with some gum resembling copal, and which required caustic potash for its removal.

Meeting of February 15th, 1895.

The President, Dr. Edw. G. Love, in the chair.

Thirty-two persons present.

Mr. Charles F. Cox addressed the Society on "The Relation of Aperture to the Determination of minute Structure." This address was illustrated by blackboard drawings, sixty lantern projections, and one hundred photomicrographs, and was discussed by the President, Prof. Stratford, Mr. F. W. Leggett and Rev. Geo. E. F. Haas.

PUBLICATIONS RECEIVED.

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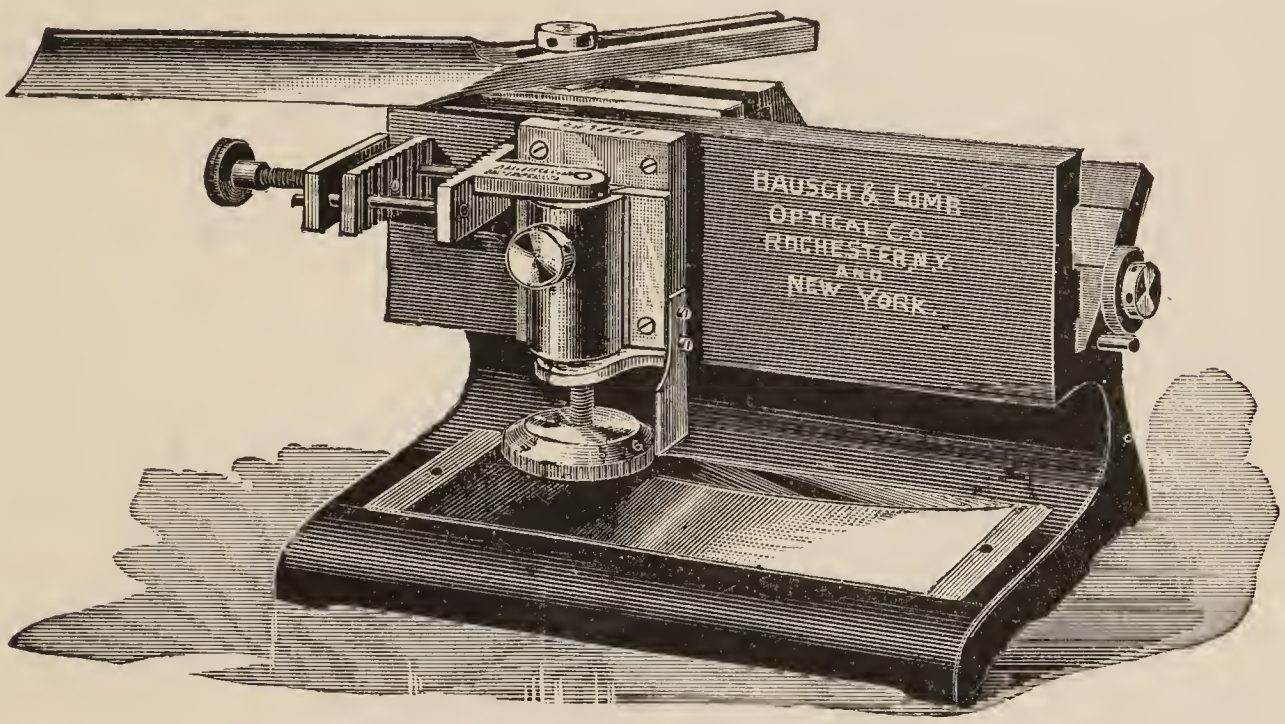

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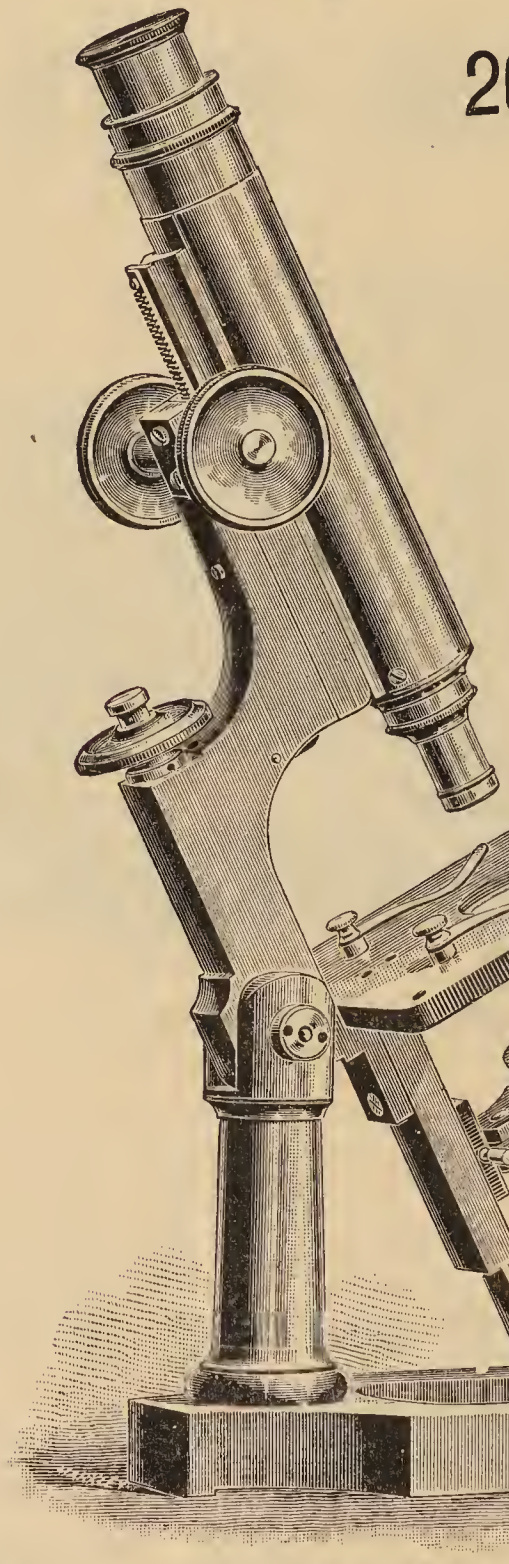

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